WHAT IS CLAIMED IS:

1. An image formation apparatus having an arrangement so that a discomfort probability P, calculated from an expression (a) , fulfills a condition (b), wherein

the discomfort probability P is calculated using a sound pressure level value, a loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value, and an impulsiveness value obtained from operation noise at a position with a distance from an end surface of the image formation apparatus,

$$\hat{P}_{i\varpi} = 1/\{1 + \exp[-z]\} \quad \ldots \text{(a)}$$

$$\hat{P}_{i\varpi} \leqq 0.2725 \cdot \ln(ppm) - 0.6331 \quad \ldots \text{(b)}$$

where

z = A $\times$ sound pressure level i + B $\times$ loudness i + C $\times$ sharpness i + D $\times$ tonality i + E $\times$ impulsiveness i + F

i = 1, 2, 3, ..., n

A, B, C, D, and E are regression coefficients of parameters, and F is intercept, and A, B, C, D, E, and F satisfy the inequalities

$0.142 \leq A \leq 0.183$

$0.300 \leq B \leq 0.389$

$1.097 \leq C \leq 1.265$

$9.818 \leq D \leq 11.516$

$2.588 \leq E \leq 3.240$

$-18.844 \leq F \leq -14.968$

ppm is a printing speed per minute for A4 horizontal size recording medium.

2. The image formation apparatus according to claim 1, wherein

values of A to F are in a range of $\pm 2\sigma$, where σ is standard error, with respect to an estimate value of each coefficient.

3. The image formation apparatus according to claim 1, wherein

a multiple logistic regression model

$$\hat{P}_{ij} = 1/\left\{1 + \exp\left[-\left(\sum_{l=1}^{L} b_l\left(x_{li} - x_{lj}\right)\right)\right]\right\},$$

where

b_l is regression coefficient

x_{li} and x_{lj} are psychological acoustic parameter values of sounds that are compared in pair

$i = 1, 2, 3, \ldots, n$

$j = 1, 2, 3, \ldots, n$

$l = 1, 2, 3, \ldots, L$,

that predicts a probability of dominance of sound based on a paired comparison of sounds transforms the expression (a) for calculating the discomfort probabilities into an expression that predicts a discomfort probability of single noise by using an average value of psycho-acoustics parameter values of whole samples used to derive a regression model expression.

4. The image formation apparatus according to claim 1, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (b).

5. The image formation apparatus according to claim 4, wherein

the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding of a recording medium.

6. The image formation apparatus according to claim 1, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (b).

7. The image formation apparatus according to claim 6, wherein

the impulse -noise reducing unit includes a medium conveyance control unit that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium, having a plurality of medium feed trays, such that only electromagnetic clutches positioned on or above a used medium feed tray or above operate.

8. The image formation apparatus according to claim 1, wherein

the discomfort probability (P), in at least a direction of an operating section, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

9. The image formation apparatus according to claim 1, wherein

an average value of the discomfort probability (P), in four directions of front, back, left, and right sides, of the sound generated by the image formation apparatus is

at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

10. The image formation apparatus according to claim 1, wherein

the discomfort probability (P), on at least one side, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

11. The image formation apparatus according to claim 1, wherein

the discomfort probability (P), on all the four sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

12. An image formation apparatus having an arrangement so that a discomfort probability P, calculated from an expression (c) , fulfills a condition (b), wherein

the discomfort probability P is calculated using a sound pressure level value, a loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value, and an impulsiveness value obtained from operation noise at a position with a distance from an end surface of the image formation apparatus,

$$\hat{P}_{i\varpi} = 1/\left\{1 + \exp\left[\begin{array}{l} 16.90601 - 0.1625723\chi_{\text{sound pressure level}} \\ -0.34475769\chi_{\text{loudness}\,i} - 1.18093783\chi_{\text{sharpness}\,i} \\ -10.6669829\chi_{\text{tonality}\,i} - 2.91380546\varphi_{\text{impulse}\,i} \\ \pm 2\hat{\sigma} \end{array}\right]\right\} \quad \ldots \text{(c)}$$

$$\hat{P}_{i\varpi} \leqq 0.2725 \cdot \ln(ppm) - 0.6331 \quad \ldots (b)$$

where

$i = 1, 2, 3, \ldots, n$

σ is standard error

ppm is a printing speed per minute for A4 horizontal size recording medium.

13. The image formation apparatus according to claim 12, wherein the standard error σ is 0.839.

14. The image formation apparatus according to claim 12, wherein a multiple logistic regression model

$$\hat{P}_{ij} = 1/\left\{1 + \exp\left[-\left(\sum_{l=1}^{L} b_l (x_{li} - x_{lj})\right)\right]\right\},$$

where

b_l is regression coefficient

x_{li} and x_{lj} are psychological acoustic parameter values of sounds that are compared in pair

$i = 1, 2, 3, \ldots, n$

$j = 1, 2, 3, \ldots, n$

$l = 1, 2, 3, \ldots, L,$

that predicts a probability of dominance of sound based on a paired comparison of sounds transforms the expression (c) for calculating the discomfort probabilities into an expression that predicts a discomfort probability of single noise by using an average value of psycho-acoustics parameter values of whole samples used to derive a regression model expression.

15. The image formation apparatus according to claim 12, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (b).

16. The image formation apparatus according to claim 15, wherein

the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding of a recording medium.

17. The image formation apparatus according to claim 12, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (b).

18. The image formation apparatus according to claim 17, wherein

the impulse -noise reducing unit includes a medium conveyance control unit that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium, having a plurality of medium feed trays, such that only electromagnetic clutches positioned on or above a used medium feed tray or above operate.

19. The image formation apparatus according to claim 12, wherein

the discomfort probability (P), in at least a direction of an operating section, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

20. The image formation apparatus according to claim 12, wherein

an average value of the discomfort probability (P), in four directions of front, back, left, and right sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

21. The image formation apparatus according to claim 12, wherein

the discomfort probability (P), on at least one side, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

22. The image formation apparatus according to claim 12, wherein

the discomfort probability (P), on all the four sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

23. An image formation apparatus having an arrangement so that a discomfort probability P, calculated from an expression (d) , fulfills a condition (b), wherein

the discomfort probability P is calculated using a sound pressure level value, a loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value, and an impulsiveness value obtained from operation noise at a position with a predetermined distance from an end surface of the image formation apparatus,

$$\hat{P}_{i\varpi} = 1/\left\{1 + \exp\begin{bmatrix} 16.90601 - 0.1625723\chi_{\text{sound pressure level}} \\ -0.34475769\chi_{\text{loudness}\, i} - 1.18093783\chi_{\text{sharpness}\, i} \\ -10.6669829\chi_{\text{tonality}\, i} - 2.91380546\chi_{\text{impulse}\, i} \end{bmatrix}\right\} \quad \ldots \text{(d)}$$

$$\hat{P}_{i\varpi} \leqq 0.2725 \cdot \ln(ppm) - 0.6331 \quad \ldots \text{(b)}$$

where

$i = 1, 2, 3, \ldots, n$

ppm is a printing speed per minute for A4 horizontal size recording medium.

24. The image formation apparatus according to claim 23, wherein

a multiple logistic regression model

$$\hat{P}_{ij} = 1/\left\{1 + \exp\left[-\left(\sum_{l=1}^{L} b_l (x_{li} - x_{lj})\right)\right]\right\},$$

where

b_l is regression coefficient

x_{li} and x_{lj} are psychological acoustic parameter values of sounds that are compared in pair

$i = 1, 2, 3, \ldots, n$

$j = 1, 2, 3, \ldots, n$

$l = 1, 2, 3, \ldots, L$,

that predicts a probability of dominance of sound based on a paired comparison of sounds transforms the expression (d) for calculating the discomfort probabilities into an expression that predicts a discomfort probability of single noise by using an average value of psycho-acoustics parameter values of whole samples used to derive a regression model expression.

25. The image formation apparatus according to claim 24, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (b).

26. The image formation apparatus according to claim 25, wherein

the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding noise of a recording medium.

27. The image formation apparatus according to claim 23, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (b).

28. The image formation apparatus according to claim 27, wherein

the impulse-noise reducing unit includes a medium conveyance control unit that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium, having a plurality of medium feed trays, such that only electromagnetic clutches positioned on or above a used medium feed tray operate.

29. The image formation apparatus according to claim 23, wherein

the discomfort probability P, in at least a direction of an operating section, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

30. The image formation apparatus according to claim 23, wherein

an average value of the discomfort probability P, in four directions of front, back, left, and right sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

31. The image formation apparatus according to claim 23, wherein

the discomfort probability P, on at least one side, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

32. The image formation apparatus according to claim 23, wherein

the discomfort probability P, on all the four sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

33. An image formation apparatus having an arrangement so that a discomfort probability P, calculated from an expression (e), fulfills a condition (f), wherein

the discomfort probability P is calculated using a sound pressure level value (A) in decibels, a loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm, obtained from operation noise at a position with a distance from an end surface of the image

formation apparatus,

$$P = \frac{1}{1 + \exp(-z)} \qquad \ldots \text{(e)}$$

$$P \leqq 0.1728e^{0.0065\,\mathrm{ppm}} \qquad \ldots \text{(f)}$$

where

$z = A \times$ sound pressure level i + $B \times$ loudness i + $C \times$sharpness i + $D \times$ tonality i + $E \times$ impulsiveness i + $F \times$ ppm i + G

$i = 1, 2, 3, \ldots, n$

A, B, C, D, E, and F are regression coefficients of parameters, and G is intercept, and A, B, C, D, E, F, and G satisfy the inequalities

$0.10547717 \leq A \leq 0.15069022$

$0.40687921 \leq B \leq 0.53399976$

$0.99138725 \leq C \leq 1.166331$

$8.38547981 \leq D \leq 10.1721249$

$2.57373312 \leq E \leq 3.21686388$

$-0.020344 \leq F \leq 0.0106576$

$-17.49359273 \leq G \leq 12.70308101$

ppm is a printing speed per minute for A4 horizontal size recording medium.

34. The image formation apparatus according to claim 33, wherein values of A to F are in a range of $\pm 2\sigma$, where σ is standard error, with respect to an estimate value of each coefficient.

35. The image formation apparatus according to claim 33, wherein

a multiple logistic regression model

$$\hat{P}_{ij} = 1/\left\{1 + \exp\left[-\left(\sum_{l=1}^{L} b_l \left(x_{li} - x_{lj}\right)\right)\right]\right\},$$

where

b_l is regression coefficient

x_{li} and x_{lj} are psychological acoustic parameter values of sounds that are compared in pair

$i = 1, 2, 3, \ldots, n$

$j = 1, 2, 3, \ldots, n$

$l = 1, 2, 3, \ldots, L,$

that predicts a probability of dominance of sound based on a paired comparison of sounds transforms the expression (e) for calculating the discomfort probabilities into an expression that predicts a discomfort probability of single noise by using an average value of psycho-acoustics parameter values of whole samples that are used to derive a regression model expression.

36. The image formation apparatus according to claim 33, wherein

the discomfort probability P, in at least a direction of an operating section, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

37. The image formation apparatus according to claim 33, wherein

an average value of the discomfort probability P, in four directions of front, back, left, and right sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

38. The image formation apparatus according to claim 33, wherein

the discomfort probability P, on at least one side, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

39. The image formation apparatus according to claim 33, wherein

the discomfort probability P, on all the four sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

40. The image formation apparatus according to claim 33, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (f).

41. The image formation apparatus according to claim 33, wherein

the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding noise of the recording medium.

42. The image formation apparatus according to claim 33, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (f).

43. The image formation apparatus according to claim 42, wherein

the impulse noise reducing unit includes a medium conveyance control unit that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium each having a plurality of medium feed trays, such that only electromagnetic clutches positioned on a used medium feed tray or above operate.

44. The image formation apparatus according to claim 33, comprising a pure-tone-component reducing unit that reduces a pure-tone-component to fulfill the condition (f).

45. The image formation apparatus according to claim 44, wherein

the pure-tone-component reducing unit includes a charging noise reducing unit that reduces charging noise generated during a charging due to an AC bias.

46. The image formation apparatus according to claim 45, wherein

the charging noise reducing unit has an eigen frequency of an image holder that is different from a frequency obtained by multiplying a natural number to a

frequency of the AC bias.

47. The image formation apparatus according to claim 45, wherein

the charging noise reducing unit has a sound absorbing member inside an image holder.

48. The image formation apparatus according to claim 45, wherein

the charging noise reducing unit has an oscillation control member inside an image holder.

49. The image formation apparatus according to claim 33, comprising a guiding member in a route of a recording medium, wherein guiding member the includes a flexible sheet having a bent end edge portion or having a thickness of one half or smaller to control the conveying route of the recording medium.

50. An image formation apparatus having an arrangement so that a discomfort probability P, calculated from an expression (g), fulfills a condition (f), wherein

the discomfort probability P is calculated using a sound pressure level value (A) in decibels, a loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm, obtained from operation noise at a position with a predetermined distance from an end surface of the image formation apparatus,

$$P = \frac{1}{1 + \exp(-z \pm 2\sigma)} \quad \ldots (g)$$

$$P \leqq 0.1728 e^{0.0065\,\mathrm{ppm}} \quad \ldots (f)$$

where

$$z = 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i + 1.07885872 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i + 2.89529674 \times \text{impulsiveness } i - 0.0155008 \times \text{ppm } i - 15.09832827$$

$i = 1, 2, 3, \ldots, n$

σ is standard error = 0.871894

ppm is a printing speed per minute for A4 horizontal size recording medium.

51. The image formation apparatus according to claim 50, wherein a multiple logistic regression model

$$\hat{P}_{ij} = 1/\left\{1 + \exp\left[-\left(\sum_{l=1}^{L} b_l \left(x_{li} - x_{lj}\right)\right)\right]\right\},$$

where

b_l is regression coefficient

x_{li} and x_{lj} are psychological acoustic parameter values of sounds that are compared in pair

$i = 1, 2, 3, \ldots, n$

$j = 1, 2, 3, \ldots, n$

$l = 1, 2, 3, \ldots, L,$

that predicts a probability of dominance of sound based on a paired comparison of sounds transforms the expression (e) for calculating the discomfort probabilities into an expression that predicts a discomfort probability of single noise by using an average value of psycho-acoustics parameter values of whole samples that are used to derive a regression model expression.

52. The image formation apparatus according to claim 50, wherein

the discomfort probability P, in at least a direction of an operating section, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

53. The image formation apparatus according to claim 50, wherein

an average value of the discomfort probability P, in four directions of front, back, left, and right sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

54. The image formation apparatus according to claim 50, wherein

the discomfort probability P, on at least one side, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

55. The image formation apparatus according to claim 50, wherein

the discomfort probability P, on all the four sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

56. The image formation apparatus according to claim 50, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (f).

57. The image formation apparatus according to claim 56, wherein

the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding noise of the recording medium.

58. The image formation apparatus according to claim 50, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (f).

59. The image formation apparatus according to claim 58, wherein

the impulse noise reducing unit includes a medium conveyance control unit that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium each having a plurality of medium feed trays, such that only electromagnetic clutches positioned on a used medium feed tray or above operate.

60. The image formation apparatus according to claim 50, comprising a pure-tone-component reducing unit that reduces a pure-tone-component to fulfill the condition (f).

61. The image formation apparatus according to claim 60, wherein

the pure-tone-component reducing unit includes a charging noise reducing unit that reduces charging noise generated during a charging due to an AC bias.

62. The image formation apparatus according to claim 61, wherein

the charging noise reducing unit has an eigen frequency of an image holder that is different from a frequency obtained by multiplying a natural number to a frequency of the AC bias.

63. The image formation apparatus according to claim 61, wherein

the charging noise reducing unit has a sound absorbing member inside an image holder.

64. The image formation apparatus according to claim 61, wherein

the charging noise reducing unit has an oscillation control member inside an image holder.

65. The image formation apparatus according to claim 50, comprising a guiding member in a route of a recording medium, wherein guiding member the includes a flexible sheet having a bent end edge portion or having a thickness of one half or smaller to control the conveying route of the recording medium.

66. An image formation apparatus having an arrangement so that a discomfort probability P, calculated from an expression (h) , fulfills a condition (f), wherein

the discomfort probability P is calculated using a sound pressure level value (A) in decibels, a loudness value of a psycho-acoustics parameter, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm, obtained from operation noise at a position with a predetermined distance from an end surface of the image formation apparatus,

$$P = \frac{1}{1 + \exp(-z)} \quad \ldots (h)$$

$$P \leqq 0.1728 e^{0.0065\,ppm} \quad \ldots (f)$$

where

$z = 0.12808364 \times$ sound pressure level i + $0.47043907 \times$ loudness i + $1.07885872 \times$ sharpness i + $9.27879937 \times$ tonality i + $2.89529674 \times$ impulsiveness i - $0.0155008 \times$ ppm i - 15.09832827

i = 1, 2, 3, ..., n

ppm is a printing speed per minute for A4 horizontal size recording medium.

67. The image formation apparatus according to claim 66, wherein a multiple logistic regression model

$$\hat{P}_{ij} = 1 / \left\{ 1 + \exp\left[- \left(\sum_{l=1}^{L} b_l (x_{li} - x_{lj}) \right) \right] \right\},$$

where

b_l is regression coefficient

x_{li} and x_{lj} are psychological acoustic parameter values of sounds that are compared in pair

i = 1, 2, 3, ..., n

j = 1, 2, 3, ..., n

l = 1, 2, 3, ..., L,

that predicts a probability of dominance of sound based on a paired comparison of sounds transforms the expression (e) for calculating the discomfort probabilities into an expression that predicts a discomfort probability of single noise by using an average value of psycho-acoustics parameter values of whole samples that are used to derive

a regression model expression.

68. The image formation apparatus according to claim 66, wherein

the discomfort probability P, in at least a direction of an operating section, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

69. The image formation apparatus according to claim 66, wherein

an average value of the discomfort probability P, in four directions of front, back, left, and right sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

70. The image formation apparatus according to claim 66, wherein

the discomfort probability P, on at least one side, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

71. The image formation apparatus according to claim 66, wherein

the discomfort probability P, on all the four sides, of the sound generated by the image formation apparatus is at a permissible level or below, at a distance of $1.00 \pm$

0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 $\pm$ 0.03 meters above the floor or 1.50 $\pm$ 0.03 meters above the floor.

72. The image formation apparatus according to claim 66, comprising a higher-frequency-component reducing unit that reduces a higher-frequency-component to fulfill the condition (f).

73. The image formation apparatus according to claim 72, wherein

the higher-frequency-component reducing unit includes a guiding member in a medium conveying unit and a sliding noise reducing unit that reduces sliding noise of the recording medium.

74. The image formation apparatus according to claim 66, comprising an impulse-noise reducing unit that reduces impulse noise to fulfill the condition (f).

75. The image formation apparatus according to claim 74, wherein

the impulse noise reducing unit includes a medium conveyance control unit that controls electromagnetic clutches, each provided on each of routes for conveying a recording medium each having a plurality of medium feed trays, such that only electromagnetic clutches positioned on a used medium feed tray or above operate.

76. The image formation apparatus according to claim 66, comprising a pure-tone-component reducing unit that reduces a pure-tone-component to fulfill the condition (f).

77. The image formation apparatus according to claim 76, wherein

the pure-tone-component reducing unit includes a charging noise reducing unit that reduces charging noise generated during a charging due to an AC bias.

78. The image formation apparatus according to claim 77, wherein

the charging noise reducing unit has an eigen frequency of an image holder that is different from a frequency obtained by multiplying a natural number to a frequency of the AC bias.

79. The image formation apparatus according to claim 77, wherein

the charging noise reducing unit has a sound absorbing member inside an image holder.

80. The image formation apparatus according to claim 77, wherein

the charging noise reducing unit has an oscillation control member inside an image holder.

81. The image formation apparatus according to claim 66, comprising a guiding member in a route of a recording medium, wherein guiding member the includes a flexible sheet having a bent end edge portion or having a thickness of one half or smaller to control the conveying route of the recording medium.

82. A method of evaluating a sound generated by an image formation apparatus when forming an image onto a recording medium, the method comprising:

recording an operation noise generated by each of a plurality of image

formation apparatuses each having a different image formation speed;

preparing a plurality of sample sounds from the operation noises;

measuring a psycho-acoustics parameter for each of the sample sounds;

evaluating the sample sounds using a paired comparison method;

carrying out a logistic regression analysis by using a discomfort probability of two kinds of sound using the evaluation of the sample sounds as objective variables and a difference of psycho-acoustics parameters as explanatory variables;

deriving a sound quality evaluation expression used to predict a probability of discomfort of sound based on a result of the logistic regression analysis; and

evaluating sound quality by using the sound quality evaluation expression.

83. The method according to claim 82, wherein the recording includes recording the operation noise binaurally.

84. The method according to claim 82, wherein the recording includes recording the operation noise of the image formation apparatus at a distance of 1.00 ± 0.03 meters from an end surface of the image formation apparatus, and at a height of 1.20 ± 0.03 meters above the floor or 1.50 ± 0.03 meters above the floor.

85. The method according to claim 82, wherein the recording includes recording the operation noise from at least a direction in which an operating unit is provided in the image formation apparatus.

86. The method according to claim 82, wherein the recording includes recording the operation noise from four directions of front, back, left, and right sides of the image formation apparatus.

87. The method according to claim 82, wherein the preparing the sample sounds includes attenuating or emphasizing portions of main sound sources, on a frequency axis or a time axis, from the operation noises.

88. The method according to claim 82, wherein the preparing the sample sound includes attenuating or emphasizing portions of at least one of main sound sources of metal impulse noise, medium impulse noise, meduim sliding noise, motor driving noise, and charging noise, on a frequency axis or a time axis, from the operation noises.

89. The method according to claim 82, wherein the psycho-acoustics parameters include one or more of a loudness value, a sharpness value, a tonality value, an impulsiveness value, a roughness value, a relative approach value, and a sound quality level value.

90. The method according to claim 82, wherein the evaluating the sample sound includes evaluating the sample sounds for each image formation speed using a paired comparison method.

91. The method according to claim 82, wherein the evaluating the sound quality includes

deriving an expression (i) concerning a discomfort probability of sound from a

result of the logistic regression analysis,

$$\hat{P}_{ij} = 1/\left\{1+\exp\left[\begin{array}{l}-0.650842(\chi_{\text{loudness } i}-\chi_{\text{loudness } j})-1.022138(\chi_{\text{sharpness } i}-\chi_{\text{sharpness } j}) \\ -12.08128(\chi_{\text{tonality } i}-\chi_{\text{tonality } j})-3.595879(\chi_{\text{impulse } i}-\chi_{\text{impulse } j})\end{array}\right]\right\} \quad \ldots \text{(i)}$$

substituting an average value of the psycho-acoustics parameter values used to derive the expression (i) into the expression (i), thereby to derive the sound quality evaluation expression.

92. The method according to claim 91, wherein the evaluating the sound quality includes

deriving the expression (i); and

substituting an average value of psycho-acoustics parameter values used to derive the expression (i) into the expression (i) while taking the probability (P) to be 0.5.

93. The method according to claim 82, wherein the deriving the sound quality evaluation expression includes

deriving an expression (j) concerning a discomfort probability of sound from a result of the logistic regression analysis,

$$P = \frac{1}{1+\exp(-z)} \quad \ldots \text{(j)}$$

where

z = 0.12808364 × (sound pressure level i - sound pressure j)

+ 0.47043907 × (loudness i - loudness j)

+ 1.785872 × (sharpness i - sharpness j)

+ 9.27879937 × (tonality i - tonality j)

+ 2.89529674 × (impulsiveness i - impulsiveness j)

$- 0.0114246 \times$ (ppm i - ppm j)

$- 0.0040762 \times$ (ppm average value i - ppm average value j)

where ppm is a printing speed per minute for A4 horizontal size recording medium; and

deriving the sound quality evaluation expression by substituting an average value of the psycho-acoustics parameter values used to derive the expression (j) into the expression (j).

94. The method according to claim 93, wherein the deriving the sound quality evaluation expression includes

deriving the expression (j); and

deriving the sound quality evaluation expression by substituting a total average value of psycho-acoustics parameter values, a printing speed per minute for A4 horizontal size recording medium, and an average value of the printing speed that are used to derive the expression (j) into the expression (j), while taking the probability (P) to be 0.5.

95. A method of manufacturing an image formation apparatus, comprising:

a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (k) fulfills the condition (l) by using a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus,

$$\hat{P}_{i\varpi} = 1/\{1 + \exp[-z]\} \quad \ldots (k)$$

$$\hat{P}_{i\varpi} \leqq 0.2725\ln(ppm) - 0.6331 \quad \ldots (l)$$

where

$$z = A \times \text{sound pressure level } i + B \times \text{loudness } i + C \times \text{sharpness } i$$
$$+ D \times \text{tonality } i + \text{impulsiveness } i + F$$

$i = 1, 2, 3, \ldots, n$

A, B, C, D, and E are regression coefficients of parameters, and F is intercept, and A, B, C, D, E, and F satisfy the inequalities

$$0.142 \leq A \leq 0.183$$
$$0.300 \leq B \leq 0.389$$
$$1.097 \leq C \leq 1.265$$
$$9.818 \leq D \leq 11.516$$
$$2.588 \leq E \leq 3.240$$
$$-18.844 \leq F \leq -14.968;$$

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

96. A method of manufacturing an image formation apparatus, comprising:

a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (m) fulfills the condition (l) by using a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus,

$$\hat{P}_{i\varpi} = 1/\left\{1+\exp\begin{bmatrix}16.90601-0.1625723\chi_{\text{sound pressure level}} \\ -0.34475769\chi_{\text{loudness}\,i}-1.18093783\chi_{\text{sharpness}\,i} \\ -10.6669829\chi_{\text{tonality}\,i}-2.91380546\chi_{\text{impulse}\,i} \\ \pm 2\hat{\sigma}\end{bmatrix}\right\} \quad \ldots \text{(m)}$$

$$\hat{P}_{i\varpi} \leqq 0.2725\ln(\text{ppm})-0.6331 \quad \ldots \text{(l)}$$

where

$i = 1, 2, 3, \ldots, n$;

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

97. A method of manufacturing an image formation apparatus, comprising:

a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (n) fulfills the condition (l) by using a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus;

$$\hat{P}_{i\varpi} = 1/\left\{1+\exp\begin{bmatrix}16.90601-0.1625723\chi_{\text{sound pressure level}} \\ -0.34475769\chi_{\text{loudness}\,i}-1.18093783\chi_{\text{sharpness}\,i} \\ -10.6669829\chi_{\text{tonality}\,i}-2.91380546\chi_{\text{impulse}\,i}\end{bmatrix}\right\} \quad \ldots \text{(n)}$$

$$\hat{P}_{i\varpi} \leqq 0.2725\ln(\text{ppm})-0.6331 \quad \ldots \text{(l)}$$

where

$i = 1, 2, 3, \ldots, n$;

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

98. A method of manufacturing an image formation apparatus, comprising:

a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (o) fulfills the condition (p) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus,

$$P = \frac{1}{1 + \exp(-z)} \qquad \ldots \text{(o)}$$

$$P \leqq 0.1728 e^{0.0065\,\mathrm{ppm}} \qquad \ldots \text{(p)}$$

where

$$z = A \times \text{sound pressure level o} + B \times \text{loudness i} + C \times \text{sharpness i} + D \times \text{tonality i} + E \times \text{impulsiveness i} + F \times \text{ppm i} + G$$

$i = 1, 2, 3, \ldots, n$

A, B, C, D, E, and F are regression coefficients of parameters, and G is intercept, and A, B, C, D, E, F, and G satisfy the inequalities

$$0.10547717 \leq A \leq 0.15069022$$

$$0.40687921 \leq B \leq 0.53399976$$

$$0.99138725 \leq C \leq 1.166331$$

$$8.38547981 \leq D \leq 10.1721249$$

$2.57373312 \leq E \leq 3.21686388$

$-0.020344 \leq F \leq 0.0106576$

$-17.49359273 \leq G \leq 12.70308101$;

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

99. A method of manufacturing an image formation apparatus, comprising:

a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (q) fulfills the condition (p) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus,

$$P = \frac{1}{1 + \exp(-z \pm 2\sigma)} \quad \text{... (q)}$$

$$P \leqq 0.1728 e^{0.0065\,\text{ppm}} \quad \text{... (p)}$$

where

$z = 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i$
$+ 1.07885782 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i$
$+ 2.89529674 \times \text{impulsiveness } i - 0.01558008 \times \text{ppm } i - 15.09832827$

$i = 1, 2, 3, ..., n$

σ is standard error = 0.871894;

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

100. A method of manufacturing an image formation apparatus, comprising:

a design step of designing each section of the apparatus so that a discomfort probability (P) calculated according to the expression (r) fulfills the condition (p) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of psycho-acoustics parameters obtained from sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, the sounds being collected at a position with a distance from an end surface of the image formation apparatus,

$$P = \frac{1}{1+\exp(-z)} \quad \text{... (r)}$$

$$P \leqq 0.1728 e^{0.0065\,\text{ppm}} \quad \text{... (p)}$$

where

$$\begin{aligned} z = {} & 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i \\ & + 1.07885872 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i \\ & + 2.89529674 \times \text{impulsiveness } i - 0.0155008 \times \text{ppm } i - 15.09832827; \end{aligned}$$

and

a manufacturing step of manufacturing the image formation apparatus according to contents designed at the design step.

101. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a probability (P) calculated according to the expression (s) fulfills the condition (t) by using a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step, where

$$\hat{P}_{i\varpi} = 1/\{1 + \exp[-z]\} \quad \ldots (s)$$

$$\hat{P}_{i\varpi} \leqq 0.2725\ln(ppm) - 0.6331 \quad \ldots (t)$$

where

$z = A \times$ sound pressure level i + B $\times$ loudness i

+ C sharpness i + D $\times$ tonality i+ E $\times$ impulsiveness i + F

$i = 1, 2, 3, \ldots, n$

A, B, C, D, and E are regression coefficients of parameters, and F is intercept, and A, B, C, D, E, and F satisfy the inequalities

$0.142 \leq A \leq 0.183$

$0.300 \leq B \leq 0.389$

$1.097 \leq C \leq 1.265$

$9.818 \leq D \leq 11.516$

$2.588 \leq E \leq 3.240$

$-18.844 \leq F \leq -14.968$.

102. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a probability (P) calculated according to the expression (u) fulfills the condition (t) by using a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step, where

$$\hat{P}_{i\varpi} = 1/\left\{1+\exp\begin{bmatrix}16.90601 - 0.1625723\chi_{\text{sound pressure level}} \\ -0.34475769\chi_{\text{loudness i}} - 1.18093783\chi_{\text{sharpness i}} \\ -10.6669829\chi_{\text{tonality i}} - 2.91380546\chi_{\text{impulse i}} \\ \pm 2\hat{\sigma}\end{bmatrix}\right\} \quad \ldots \text{(u)}$$

$$\hat{P}_{i\varpi} \leqq 0.2725\ln(\text{ppm}) - 0.6331 \quad \ldots \text{(t)}$$

where

i = 1, 2, 3, ..., n

σ is standard error.

103. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a probability (P) calculated according to the expression (v) fulfills the condition (t) by using

a loudness value, a sharpness value, a tonality value, and an impulsiveness value of psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step.

$$\hat{P}_{i\varpi} = 1/\left\{1+\exp\begin{bmatrix}16.90601-0.1625723\chi_{\text{sound pressure level}} \\ -0.34475769\chi_{\text{loudness}\,i}-1.18093783\chi_{\text{sharpness}\,i} \\ -10.6669829\chi_{\text{tonality}\,i}-2.91380546\chi_{\text{impulse}\,i}\end{bmatrix}\right\} \quad \ldots (v)$$

$$\hat{P}_{i\varpi} \leqq 0.2725\ln(\text{ppm})-0.6331 \quad \ldots (t)$$

where

$i = 1, 2, 3, \ldots, n$.

104. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a probability (P) calculated according to the expression (w) fulfills the condition (x) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step,

$$P = \frac{1}{1+\exp(-z)} \quad \ldots (w)$$

$$P \leqq 0.1728\,e^{0.0065\,\text{ppm}} \quad \ldots (x)$$

where

$$z = A \times \text{sound pressure level } i + B \times \text{loudness } i + C \text{ sharpness } i + D \times \text{tonality } i + E \times \text{impulsiveness } i + F \times \text{ppm } i + G$$

$i = 1, 2, 3, \ldots, n$

A, B, C, D, E, and F are regression coefficients of parameters, and G is intercept, and A, B, C, D, E, F, and G satisfy the inequalities

$$0.10547717 \leq A \leq 0.15069022$$

$$0.40687921 \leq B \leq 0.53399976$$

$$0.99138725 \leq C \leq 1.166331$$

$$8.38547981 \leq D \leq 10.1721249$$

$$2.57373312 \leq E \leq 3.21686388$$

$$-0.020344 \leq F \leq 0.0106576$$

$$-17.49359273 \leq G \leq 12.70308101$$

ppm is a printing speed per minute for A4 horizontal size recording medium.

105. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a probability (P) calculated according to the expression (y) fulfills the condition (x) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step,

$$P = \frac{1}{1 + \exp(-z \pm 2\sigma)} \quad \text{... (y)}$$

$$P \leqq 0.1728 e^{0.0065\,ppm} \quad \text{... (x)}$$

where

$z = 0.12808364 \times$ sound pressure level i + $0.47043907 \times$ loudness i + $1.07885872 \times$ sharpness i + $9.27879937 \times$ tonality i + $2.89529674 \times$ impulsiveness i - $0.0155008 \times$ ppm i - 15.09832827

$i = 1, 2, 3, \ldots, n$

σ is standard error = 0.871894

ppm is a printing speed per minute for A4 horizontal size recording medium.

106. A method of remodeling an image formation apparatus comprising:

a sound collecting step of collecting sounds that the image formation apparatus emits at the time of forming an image onto a recording medium, at a sound collection position with a distance from an end surface of the image formation apparatus to be remodeled; and

a remodeling step of remodeling a configuration of the apparatus so that a probability (P) calculated according to the expression (z) fulfills the condition (x) by using a loudness value, a sharpness value, a tonality value, an impulsiveness value, and a printing speed ppm for A4 horizontal size medium per minute, of psycho-acoustics parameters obtained from a result of the sound collected at the sound collecting step, where

$$P = \frac{1}{1 + \exp(-z)} \quad \text{... (z)}$$

$$P \leqq 0.1728 e^{0.0065\,ppm} \quad \text{... (x)}$$

where

$$z = 0.12808364 \times \text{sound pressure level } i + 0.47043907 \times \text{loudness } i$$
$$+ 1.07885872 \times \text{sharpness } i + 9.27879937 \times \text{tonality } i$$
$$+ 2.89529674 \times \text{impulsiveness } i - 0.0155008 \times \text{ppm } i - 15.09832827$$

$i = 1, 2, 3, \ldots, n.$